Comparisons of Chemical and Pesticide Usage between Burley and Rice Farming: Economics Cost should be Realized

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Abstract

Since the year 2000, the Thai government has started to become aware of problems associated with chemical and pesticide residues left on tobacco, especially burley, which is grown in Sri Sumrong district, Sukhothai Province, the main region for burley farming in Thailand. This research attempted to compare and analyze the economics cost per hectare resulting from the chemicals and pesticides used in burley and rice farming in this area. The two sample groups in this study were 80 families who grew burley in Tub Peung subdistrict and 50 families who grew rice in Ban Rai subdistrict. The survey is carried out using a standard questionnaire with structured questions. The findings were that 58.75 % of burley farmers used highly hazardous chemicals and pesticides according to WHO standards. The statistically significant difference in the amount of chemicals used in burley farming and those used in rice farming was 0.05 ($p = 0.05$). Additionally, the economics costs resulting from chemical and pesticides use in burley farming were 2,307.44 baht (72.11, USD) per hectare. This cost was higher than those in rice farming, $p=0.05$. According to these findings, the province's agriculture department should realize that increasing land productivity comes with not only higher income but also hidden economics costs from chemical usage.

Keywords: Tobacco, Economics costs, Chemical and pesticide usage

Introduction

Chemical and pesticide usage in the burley farming is a problem that the Thai government has accepted since the year 2000. The Ministry of Finance has developed criteria to prevent and control chemicals in tobacco after R. J. Reynolds Tobacco Company, U.S.A., found that the level of chemicals in burley imported from Thailand was higher than the standards set by the Ministry of Agriculture, USA. The main region for burley farming in Thailand is Sukhothai Province, and the researcher was concerned that the burley farmers in this area must have faced health problems resulting from chemical and pesticide usage. On top of health problems, the Office of Agriculture of Sukhothai Province pointed out that although Tub Peung subdistrict was one of the main areas of burley farming, the burley farming in this area has suffered continual losses of about 224 USD per rai (Jirawat, 2009, pp. 37-49) The losses result in part from opportunity loss of the laborers. Consequently, the economics cost per rai rose to 512 USD, a figure which does not even include the health care expenses of the burley farmers. To clarify the economics cost, the first research question was therefore to determine the hidden economics cost of the burley farmers using chemical and pesticide usage.

Up to the present period, the economics of tobacco farming has been quantitatively known little of the economics costs resulting from chemical and pesticide usage in Thailand. None of the previous studies, further, considered expenses relating to farmers' medical treatment as one of the costs. According to a study of burley farming in Pakistan (Qamar, Khan, Ashfaq, Ahmad, & Idress, 2006) burley farming was profitable. Another study,

however, found that burley farming in America cost was included (Foreman, 2005 and 2006). On the other hand, Keysera, & Juitab (2005) did a comparative study comparing profitability of tobacco and other crops in Indonesia. The study showed chili farming was more profitable than tobacco farming. Therefore, the research question of the health costs resulting from chemical and pesticide usage as mentioned earlier would inform the economics of tobacco farming in order to develop the next future research.

Apart from this, the level of chemicals in farmers' blood reported by the Public Health Department, Sukhothai, was 18.88%, 'highly at risk,' and the rate of illnesses involving chemicals was at 9.27 per a hundred thousand people. This might seem trivial, however, the researcher suggested that it would be more informative to distinguish between burley farmers and other farmers. The information could be especially useful for policy makers. The researcher investigated the area's geography and found that this area was mostly low-lying land, which suited rice growing. The farmers in this area had never grown tobacco before. Therefore, the purposes of the study suffered a financial loss if the full economic were 1) to compare and analyze the chemical and pesticide usage between burley and rice growing and 2) to estimate the economics costs per hectare of burley resulting from chemical and pesticide usage.

To attain the objectives of this study, the conceptual framework was formulated (Figure 1). It also was drawn from studies involving health costs from chemical and pesticide usage in farming other agricultural products in Thailand (Table 1). The rest of paper is organized as follows. The section 2 summaries the research method consisted of three steps: 1) determination of population and sample groups, 2) building up the research tool and 3) analysis of data. The section 3 documents the main findings and discussion separated into two parts. That is the chemical and pesticide usage and health costs resulting from chemical and pesticide usage. Moreover, the discussion of the health costs of other crops in their studies (Table 1) with those of burley farming in this study will be presented in the second part of section 3. The recommendation of this study is concluded in the last section.

Table 1 The summary of the economics costs involving chemical and pesticide usage

Research	Crop	Location	Cost (baht per household)	Cost in 2011 (baht per household)
Suwanna (1992)	Mandarin	PATHUM THANI	540 (16.88, USD) and 1,366 (42.69, USD)	946.89 (29.59, USD) and 2,395.29 (74.85, USD)
Cherapa (1993)	Cotton	SARABURI	110 (3.44, USD) and 278 (8.69, USD)	187.27 (5.85, USD) and 473.28 (14.79, USD)
Chadrudee (1996)	Cotton	NAKHONRATCHASIMA	402 (12.56, USD)	626.30 (19.57, USD)
Suchittra (1998)	Rice	CHACHOENGSAO	399 (12.47, USD)	585.94 (18.31, USD)
Opal (2000)	Mango Cauliflower	CHIANG MAI	1,517 (47.41, USD) 1,292 (40.38, USD)	2,227.77 (69.62, USD) 1,788.43 (55.89, USD)

Note: The calculation is based on the 3% interest rate.

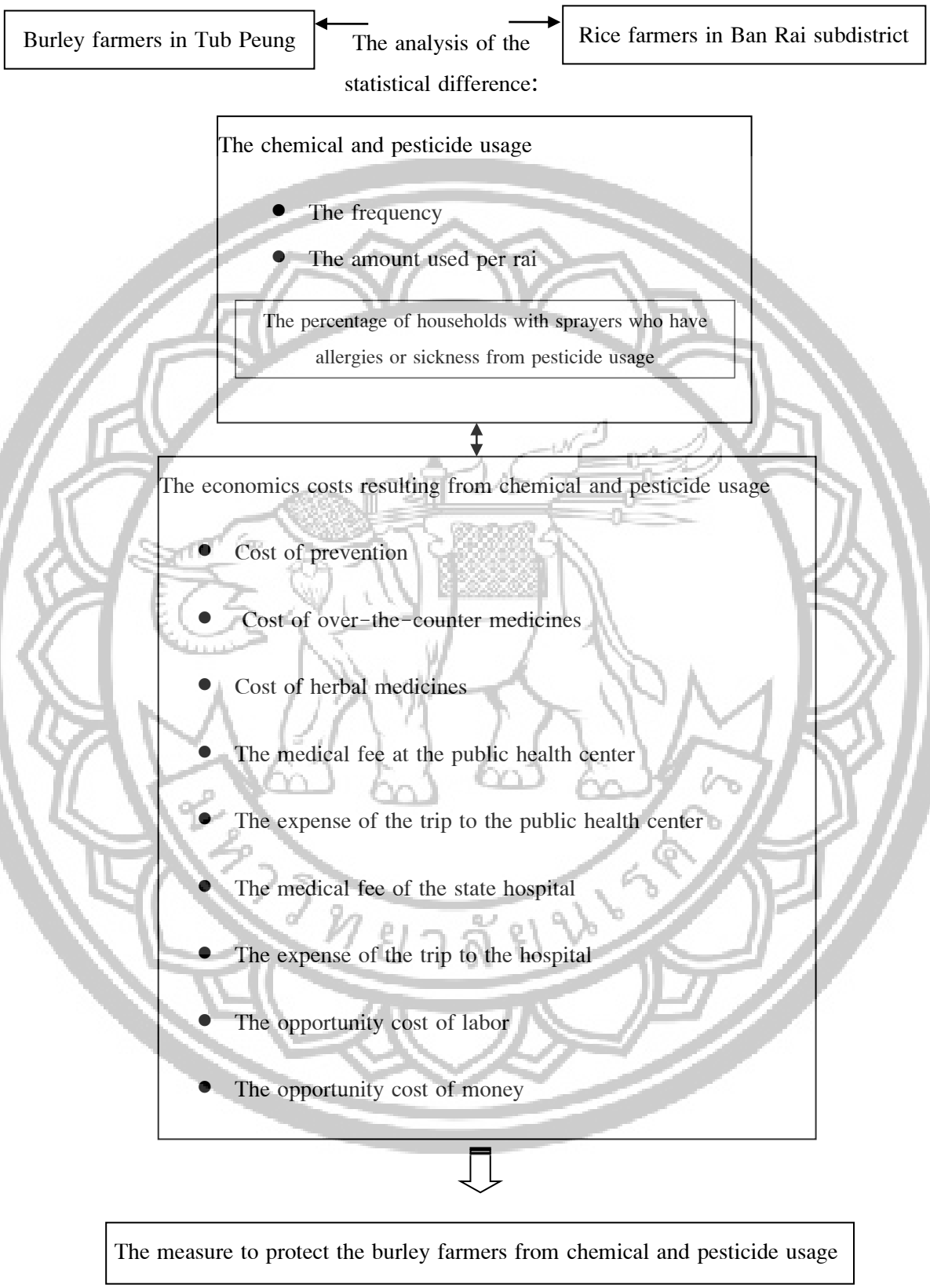

Figure 1 Research's conceptual framework

Research method

The population and sample groups

The study populations in this study were families who grew burley and families who had never grown burley before in Sri Sumrong district, Sukhothai Province. After examining the number of farmers in the 2007/2008 agricultural seasons, Tub Peung subdistrict was indicated as the experimental group and Ban Rai subdistrict, which had the highest number of farmers among three other villages which did not have a quota to grow tobacco due to its geography, was the sample group. The researcher used merely 10% of the whole population, 80 of 829 burley grower households and 50 of 489 rice farmer households in this study. This is because most burley and rice grower households in such areas would be in kind of small farming. Thus, we assume they are homogeneous farm. Accidental sampling was employed to define the research sample.

The research tools

The research tool was a set of interview questions for burley famers in Tub Peung subdistrict and non-burley farmers in Ban Rai subdistrict. The interview questions were divided into 3 parts: social backgrounds, chemical and pesticide usage information and farmers' health conditions and health care expenses. The interview questions were examined by two experts: an economics expert and a public health expert. The interview questions were tried out before actual use.

The data analysis

The data were collected in October 2011 and recorded for analysis as follows:

1. Descriptive statistics: frequency, percentage, average and standard deviation were employed to analyze the population and estimate the health costs from chemical and pesticide usage by burley farmers in Tub Peung subdistrict and rice farmers in Ban Rai subdistrict, which are presented in Table 2. Although the computation on the cost, which was not in cash, might seem overestimated due to the OP budget per head, the primary data indicated that only 20% of the number of households with members who had health problems from chemical and pesticide usage sought treatment from hospitals.

2. Inference statistics were employed to test the hypothesis of the differences between the populations of Tub Peung subdistrict and Ban Rai subdistrict. The two parameters in this study were proportion and mean. Z Statistics was used in the proportion and t was used in the mean. The hypothesis test would be a one way test. The researcher would examine the variables if the variables between the two population groups were different from t Statistics.

Table 2 How to calculate the annual average economics costs resulting from chemical and pesticides use per Household

Expense	The calculation
1. Cost of prevention	1. Cash: the sum of the cost of medicine using before or after the spraying, the cost of masks, the body suits, gloves, and boots divides by the number of the household sample.

Table 2 (cont.)

Expense	The calculation
2. Cost of over-the-counter medicines	2. Cash: (The sum of the cost of over-the-counter medicines of the first member of every household ÷ the number of the household sample) + (The sum of the cost of over-the-counter medicines of the second member of every household ÷ the number of the household sample)
3. Cost of herbal medicines	3.Non-cash: (The cost of the herbal medicines estimated by the first member of every household which use the medicines ÷ the number of household sample) + (The cost of the herbal medicines estimated by the second member of every households which use the medicines ÷ the number of household sample)
4. The medical fee at the public health center	4. Non-cash: the information retrieved from the Tub Peung subdistrict's public health center in 1997 included the service charge and the medicine bills of the patients with symptoms involving chemical and pesticide usage, 30.10 baht per head ((30.10 × The number of the patients who visited the center) ÷ the number of the household sample)
5. The expense of the trip to the public health center	5. Cash: (The total of the cost of a round trip of the first member visiting the public health center ÷ the number of the household sample) + (The total of the cost of a round trip of the second member visiting the public health center ÷ the number of the household sample)
6. The medical fee of the state hospital	6. Non-cash: (795.39 × the number of the members who visited state hospitals), the information retrieved from the OP budget in 1997 (http://phitsanulok.nhso.go.th/)
7. The expense of the trip to the hospital	7. Cash: (The total cost of the round trip to hospital of the first member of the households ÷ the number of the household sample) + (The total cost of the round trip to hospital of the second member of the households ÷ the number of the household sample)

Table 2 (cont.)

Expense	The calculation
8. The opportunity cost of labor	8. Non-cash: ((The number of sick leave days involving chemical usage of the first member × the daily wage) ÷ the number of household sample) + ((The number of sick leave days involving chemical usage of the second member × the daily wage) ÷ the number of household sample)
9. The opportunity cost of money	9. Non-cash: the interests are supposed to receive if the money were deposit at a bank (2.5% per year × the total of items 1- 8)

Results and Discussion

The chemical and pesticide usage

The investigation indicated that 58.75 % of the tobacco farmers used Landnet as insecticides, 40% used Metalaxyl for pesticides and 31.94% used Pantera as herbicides. The Thailand Tobacco Monopoly would announce the names of the brands for farmers to choose from and then the chosen brands must be rotated. The Thailand Tobacco Monopoly would not allow farmers to use the same brand repeatedly. According to the WHO (2010), Metalaxyl and Pantera were classified as slightly hazardous, class III. Landnet was classified as highly hazardous, class Ib. When these chemicals were used, they were diluted in 200 liters of water. To give an example of usage, when farmers wanted to kill worms, they would mix several brands of pesticides together with water and use it. The amount of pesticides, plant diseases and herbicides respectively were 6.19, 4.56 and 3.06 milliliters per hectare. The frequency of using these chemicals was respectively 8, 6 and 4 times per year.

On average, two people per household were used to spray these chemicals according to the survey data. For 0.16-0.64 hectare of tobacco, one sprayer would do it with a tank on his/her back. For a larger area, one worker would hold the nozzle and the other would hold the hose to spray. One sprayer had been using the chemicals for 18 years. 50% of households have used the same amount of chemicals for 5 years. 30% of households reported using less in the last 3 years. More than half of the population wanted to stop using these chemicals altogether, and nearly all of them have considered returning to using natural or organic pesticides. This would be a good signal for the campaign for natural pesticides and herbicides. However, farmers needed to see strong outcomes if they were to continue using natural pesticides and herbicides.

Tup Peung subdistrict's public health center knew about the health problems and organized training courses for chemical usage. More than 90% of the population in the subdistrict had participated in these courses. It was not surprising to see a very high average score, 22.23 out of 24 points, on what chemical users should do before, in between and after spraying. The topics which received the lowest score were 1) not to eat, drink or smoke while spraying and 2) to always stand upwind while spraying. On the prevention issue, the number of farmer families

who used gloves, boots and masks were 91.25%, 90.00% and 70.00%, respectively. The number of farmers who used protective suits while spraying or took medicine before or after the spraying was very small. In brief, burley farmers in Tup Peung subdistrict knew how to protect themselves when using herbicides. This could be the result of the training courses and workshops the government provided.

The analysis of herbicide usage led to the statistical comparison of chemical usage of tobacco farmers and non-tobacco farmers to see whether the differences were statistically significant, using descriptive statistics (p=0.05), as shown in Table 3. The results show that the percentage of households in Tub Peung subdistrict that were trained in chemical usage was statistically higher those of households in Ban Rai subdistrict. According to Ban Rai subdistrict's public health center staff, the trainings the government provided started 10 years ago and these trainings resulted in farmers becoming knowledgeable about herbicide usage. However, the number of training courses offered had declined. Tub Peung subdistrict's public health center realized this problem still existed and continued offering the trainings.

The trainings resulted in a high average score (compared to perfect scores) of the evaluation of the farmer's behavior across the two subdistricts. There was no significant difference ($p = 0.05$) (Parameter 2, Table 3). On protection during herbicide usage, the proportion of mask using in Tub Peung subdistrict was less than those in Ban Rai subdistrict, with statistically significant difference ($p = 0.05$) (Parameter 4, Table 3). The proportion of using medicine before and after the spraying in Tub Peung subdistrict was higher with statistically significant difference ($p = 0.05$) (Parameter 3, Table 3). On the other prevention methods: wearing protecting suits, gloves and boots, Tub Peung and Ban Rai subdistricts had no statistically significant differences ($p = 0.05$) (Parameter 5-7, Table 3). It can therefore be said that burley farmers in Tub Peung subdistrict were as aware of safe herbicide usage as rice farmers in Ban Rai subdistrict.

For the variable on the duration of chemical use of sprayer 1 and sprayer 2, the results showed that the average of the variable of Tub Peung subdistrict was less than those of Ban Rai subdistrict, with significant difference ($p = 0.05$) (Parameters 8-9, Table 3). The percentage of households with sick or chronic diseases in Tub Peung subdistrict was higher than those of Ban Rai subdistrict, with significant difference ($p = 0.05$) (Parameter 10, Table 3). The tobacco farmers' diseases were headaches, dizziness, sore throats, coughing and nausea. The chronic diseases were medicine allergies, high blood pressure, diabetes and thyroid conditions.

The issues worth considering were the frequency of usage and the amount of usage per hectare. According to the analysis, it was found that highly hazardous chemicals were used in the burley farming, but the differences in the frequency of chemical usage in tobacco and rice farming were not clear: there was no significant difference in the frequency of pesticide usage ($p = 0.05$) (Parameters 12, Table 3). The amount of chemicals used in tobacco farming was higher than those used in rice farming, with significant difference ($p = 0.05$) (Parameters 14-16, Table 3). The percentage of households that used chemicals in Tub Peung subdistrict increased from the last five years at a rate higher than those in Ban Rai subdistrict, with significant difference ($p = 0.05$) (Parameter 17, Table 3). The increasing environmental problems have consequently worsened the problems of insects, plant diseases and weeds. Thus, the cause of the health problems of tobacco farmers is not likely to derive from the way the

farmers used chemicals. Rather, it is likely to be the fact that they faced an increased severity of agricultural pests.

Although the results of the study indicated significant difference ($p = 0.05$) in the percentage of the households that considered using organic or natural pesticides (Parameter 18, Table 3), the percentage of households that considered using organic pesticides in Tub Peung subdistrict was less than those in Ban Rai subdistrict, with no significant difference ($p = 0.05$) (Parameter 19, Table 3). It can be concluded that the problems were not derived from the farmers who did not use natural or organic pesticides. In fact, the farmers would welcome reducing chemical usage if there was a better alternative.

Table 3 The analysis of the differences of chemical and pesticide usage of the sole burley and rice farming

Parameter	Item	The sole burley farming households	The sole rice farming households	Z Calculate	The average for burley farming	The average for rice farming	F calculate	t calculate
1	Households trained in the chemical and pesticide usage	91.14%	30.00%	7.220**	-	-	-	-
2	The average of the evaluation of how farmers used the chemical and pesticide	-	-	-	22.29	22.64	6.629**	-
3	Households taking medication before and after the chemicals and pesticides usage	41.25%	0.00%	5.258**	-	-	-	1.461^{NS}
4	Households wearing masks while using the chemical and pesticide	70.00%	98.00%	-3.941**	-	-	-	-
5	Households wearing protection suit	62.50%	62.50%	0.000^{NS}	-	-	-	-
6	Households wearing gloves while using the chemical and pesticide	91.25%	94.00%	-0.572^{NS}	-	-	-	-
7	Households wearing boots while using the chemical and pesticide	90.00%	96.00%	-1.249^{NS}	-	-	-	-
8	The duration of pesticide usage of the first member (year)	-	-	-	17.68	25.80	1.078^{NS}	-4.469**
9	The duration of chemical and pesticide usage of the second member (year)	-	-	-	16.10	23.00	1.063^{NS}	-3.163**

Table 3 (cont.)

Parameter	Item	The sole burley farming households	The sole rice farming households	Z Calculate	The average for burley farming	The average for rice farming	F calculate	t calculate
10	Households with unhealthy farmers before using chemical and pesticide usage	18.750%	0.000%	3.255**	-	-	-	-
11	The frequency of insecticide usage in one farming season (times per year)	-	-	-	7.60	5.85	9.801**	3.889**
12	The frequency of pesticide usage in one farming season (times per year)	-	-	-	5.66	5.85	4.741**	0.327^{NS}
13	The frequency of herbicide usage in one farming season (times per year)	-	-	-	4.22	5.83	4.439**	4.867**
14	The amount of insecticide usage per hectare(millimeters)	-	-	-	6.19	0.63	485.496**	9.212**
15	The amount of pesticide usage per hectare (millimeters)	-	-	-	4.56	0.56	337.976**	4.347**
16	The amount of herbicide usage per hectare (millimeters)	-	-	-	3.06	0.63	104.736**	8.378**
17	Households increasing chemical and pesticides usage compared to those 5 years ago	22.50%	6.00%	2.487**	-	-	-	-
18	Households planning to stop using chemical and pesticides	67.50%	100.00%	-4.507**	-	-	-	-
19	Households planning to use organic or natural pesticides	96.25%	100.00%	-1.385^{NS}	-	-	-	-
20	Households whose member have allergies involving chemical and pesticide usage	47.50%	4.00%	5.228**	-	-	-	-

The economics costs resulting from chemical and pesticide usage

The analysis of tobacco farmers' health involving chemical usage showed that 47.50 % of the households of sprayers had allergies or diseases involving chemical usages, with only acute attack. Among these households, it was found that the first member of the families respectively had dizziness and nausea, 92.11% and 78.95%, and the second member of the families suffered from similar conditions. This result correlates with previous studies, for example the chemical usage in mandarin orchards (Suwanna, 1992) and cauliflower farming (Opal, 2000).

In addition, the study indicated that 2.63% of the households had a first member who experienced bouts of unconsciousness. However, there were no households with a second member with the same symptom. The percentage of the households with first members who had chest pain and difficulty breathing were 36.84% and 26.32%, respectively. The researcher was concerned with the health problems of the tobacco farmers who used chemicals and pesticides in Tub Peung subdistrict. From an economic perspective, allergies and sickness must be included in the opportunity cost of the laborers because the tobacco farmers must take days off to recover when they are sick. To treat the illnesses, 86.84 % of the households took the first member to public health centers. The next alternatives were taking medicine, taking Thunbergia, and going to state hospitals. In the case of the second members, they would use the same procedures as the first mebers.

According to the statistical analysis, the percentage of the households whose members have allergies or sicknesses involving chemical and pesticide usage in Tub Peung subdistrict was higher than those of households in Ban Rai subdistrict, with statistical significance ($p = 0.05$) (Parameter 20, Table 3). This indicates that the health problems involving chemical and pesticide usage of tobacco farmers in Tub Peung subdistrict are clearly more serious than those of rice farmers. The question is why it is like this. According to the statistical comparison of the previous topic, it can be seen that the tobacco farmers behave quite well, but tobacco farming must use relatively high amount of chemicals, pesticides, herbicides and weed killers per hectare. In addition, most chemical users in Tub Peung subdistrict have suffered from poor health.

From an economic perspective, the treatments of the illnesses involving chemicals and pesticides brought many expenses both in cash and non-cash, including travel expenses and medical fees. Although tobacco farmers who are on social welfare do not have to pay the medical fees, the government spends more budgets. The estimate of economics costs shows that each household of tobacco farmers who use chemicals and pesticides in Tub Peung subdistrict must pay 2,472.00 baht (77.25, USD) (Table 4). This finding correlates with some previous studies. However, each plant requires different amounts and usage of chemicals. The economics costs start from 187.27 baht (6.24, USD) for cotton farmers to 2,395.29 baht (74.85, USD) for mandarin farmers (Table 1). The cost analysis showed that half of the cost was non-cash. The highest portion of the cost was the opportunity cost of labor. Further, in duration of sick leave, the labors are not be able to work in the farm. Thus, it seems to be opportunity loss to receive wage.

The economics costs resulting from chemical and pesticides use per hectare mean that chemical usage in tobacco farming added 2,307.44 baht (72.11, USD) per hectare (Table 4). According to Jirawat (2009), the tobacco farming in Tub Peung subdistrict, Si Samrong district suffered financial

losses at 39,223.63 baht (1,225.74 USD) per hectare because of the non-cash hidden cost. The findings in this study clearly inform what must be included in the calculation of the cost. The economics costs resulting from chemical and pesticides use was generally perceived as not very high, but, when compared to those of rice farming, it was considered relatively high (Table 5). The study found that such cost per hectare in rice framing were about 688.50 baht (21.52, USD). The results correlate with some previous studies for example, Suchittra (1998), who found that the economics costs resulting from chemical and pesticides use of the rice farmers in Chachoengsao was 607.50 baht (18.98, USD) per hectare.

The analysis of the structures of the economics costs resulting from chemical and pesticides use suggested that the number of rice farmer families with allergies or sickness was much less than those of tobacco farmer families. Only 26.14 % of the total cost was non-cash cost, particularly the laborer's opportunity loss from taking sick leave (Table 5). The tobacco farmers' health was considered one of the economic costs, and this signals the seriousness of the problem of the chemical usage in Tub Peung subdistrict, Si Samrong district, Sukhothai Province. This finding is one of the factors in decision making to reduce the tobacco farming areas and to offer more land for other types of plants, for example off-season rice. The comparative study of the health costs of chemical and pesticide usage in burley and rice farming shows that the costs in tobacco farming is higher than those of the rice farming, with statistical difference ($p = 0.05$) (Table 6); therefore, the tobacco farmers' health problems from chemical and pesticide usage is clearly more severe than those of rice farmers.

Table 4 The annual average economicscosts for burley farmers using chemical and pesticide in Tub Peung subdistrict

Item	(USD per household)				Total	
	Cash		Non-cash			
Cost of prevention	29.84	38.63%	-	-	29.84	38.63%
Cost of over-the-counter medicines	0.85	1.10%	-	-	0.85	1.10%
Cost of herbal medicines	-	-	0.60	0.77%	0.60	0.77%
The medical fee at the public health center	-	-	0.59	0.76%	0.59	0.76%
The expense of the trip to the public health center	0.52	0.68%	-	-	0.52	0.68%
The medical fee of the state hospital	-	-	2.80	3.62%	2.80	3.62%
The expense of the trip to the hospital	1.17	1.52%	-	-	1.17	1.52%
The opportunity cost of labor	-	-	39.00	50.49%	39.00	50.49%
The opportunity cost of money	-	-	1.88	2.44%	1.88	2.44%
Total	**32.38**	**41.92%**	**44.87**	**58.08%**	**77.25**	**100.00%**

Table 4 (cont.)

Item	(USD per hectare)				Total	
	Cash		Non-cash			
Cost of prevention	22.52	31.23%	-	-	22.52	31.23%
Cost of over-the-counter medicines	0.58	0.81%	-	-	0.58	0.81%
Cost of herbal medicines	-	-	0.41	0.56%	0.41	0.56%
The medical fee at the public health center	-	-	0.46	0.64%	0.46	0.64%
The expense of the trip to the public health center	0.41	0.56%	-	-	0.41	0.56%
The medical fee of the state hospital	-	-	2.25	3.13%	2.25	3.13%
The expense of the trip to the hospital	0.95	1.31%	-	-	0.95	1.31%
The opportunity cost of labor	-	-	42.77	59.32%	42.77	59.32%
The opportunity cost of money	-	-	1.76	2.44%	1.76	2.44%
Total	**24.45**	**33.91%**	**47.65**	**66.09%**	**72.11**	**100.00%**

Table 5 The annual average economics costs for rice farmers using chemical and pesticide in Ban Rai subdistrict

Item	(USD per household)				Total	
	Cash		Non-cash			
Cost of prevention	43.01	73.12%	-	-	43.01	73.12%
Cost of over-the-counter medicines	0.04	0.06%	-	-	0.04	0.06%
Cost of herbal medicines	-	-	0.06	0.10%	0.06	0.10%
The medical fee at the public health center	-	-	0.08	0.13%	0.08	0.13%
The expense of the trip to the public health center	0.15	0.25%	-	-	0.15	0.25%
The medical fee of the state hospital	-	-	0.99	1.69%	0.99	1.69%
The expense of the trip to the hospital	0.25	0.42%	-	-	0.25	0.42%
The opportunity cost of labor	-	-	12.81	21.78%	12.81	21.78%
The opportunity cost of money	-	-	1.43	2.44%	1.43	2.44%
Total	**43.45**	**73.86%**	**15.38**	**26.14%**	**58.83**	**100.00%**

Table 5 (cont.)

Item	(USD per hectare)				Total	
	Cash		Non-cash			
Cost of prevention	15.78	73.32%	-	-	15.78	73.32%
Cost of over-the-counter medicines	0.02	0.08%	-	-	0.02	0.08%
Cost of herbal medicines	-	-	0.02	0.09%	0.02	0.09%
The medical fee at the public health center	-	-	0.03	0.14%	0.03	0.14%
The expense of the trip to the public health center	0.07	0.34%	-	-	0.07	0.34%
The medical fee of the state hospital	-	-	0.31	1.44%	0.31	1.44%
The expense of the trip to the hospital	0.08	0.36%	-	-	0.08	0.36%
The opportunity cost of labor	-	-	4.69	21.79%	4.69	21.79%
The opportunity cost of money	-	-	0.53	2.44%	0.53	2.44%
Total	**15.94**	**74.10%**	**5.57**	**25.90%**	**21.52**	**100.00%**

Table 6 The analysis of the differences of the economics costs per rai of the chemical and pesticide usage of sole burley and rice farming

Parameter	Item	The average for sole burley farming	The average for sole rice farming	F calculate	t calculate
21	The economics costs of chemical and pesticide usage (baht per rai)	369.19 (72.11 USD per ha)	110.16 (21.52 USD per ha)	34.56**	2.633**

Note: An asterisk ** denotes statistical significance at the 5% level.

Conclusion and policy recommendation

The purposes of the study were 1) to compare and analyze the chemical and pesticide usage between burley and rice growing and 2) to estimate the health costs per hectare of burley resulting from chemical and pesticide usage. As the main results, the study revealed that the chemicals and pesticides utilized in tobacco farms in Tub Peung subdistrict, Sri Sumrong district, Sukhothai Province were highly hazardous, according to WHO standards. Therefore, every year the Thailand Tobacco Monopoly should announce the level of toxicity of the chemicals and pesticides to allow burley farmers to make an informed decision regarding their use. At the same time, according to the comparative study of the health problem of the tobacco farmers using chemicals in Tub Peung subdistrict and those of rice farmers in Ban Rai subdistrict, it can be inferred that it was not the fault of farmers themselves, rather it was the current

conditions of tobacco farming, which requires significantly more chemicals per hectare than those of rice farming. Therefore, tobacco farmers should use natural pesticides in their farms.

With regard to an economic view, the treatments of the illnesses involving chemicals and pesticides brought many expenses both in cash and non-cash, including travel expenses and medical fees. The cost analysis revealed that half of the cost was non-cash. The highest portion of the cost was the opportunity loss of labor from taking sick leave. In sum, the findings show that the health costs resulting from chemicals used in burley farming in Tub Peung subdistrict, Sri Sumrong district, Sukhothai Province was 2,307.44 baht (72.11, USD) per hectare. Therefore, the province's agriculture department should realize that increasing land productivity comes with not only higher income but also hidden health costs from chemical usage.

Last but not least, the main result revealed that the estimate of health costs per rai for rice farming was much lower than those of burley farming. The hidden cost of rice farming was much lower and the risk associated with chemical usage in rice farming was relatively low. This implies that rice should receive consideration as an alternative crop for Tub Peung subdistrict. In November, farmers can start farming and harvest in March. However, the fluctuation of rice prices in Thailand is another important element in decision making for gradually reducing the tobacco farming area.

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